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THE WIDER USE OF NEW TYPES OF STEEL IN THE USSR

The successful measures adopted to save alloying metals guarantee large technical-economic benefits for the metallurgical industry. The saving of alloying metals makes it possible to increase the output of alloys and alloy steels. In particular, there is the possibility of expanding the production of high-strength low-alloy steels. The use of these steels instead of ordinary carbon steel, in turn, creates a saving of metal by lightening the weight of machines and instruments.

The conservation of valuable alloying metals and ferroalloys falls into two basic categories. First, this saving should be accomplished during the smelting operations by the introduction into the smelting shops of restricted intrashop limits of steel analysis for alloy components and by their efficient recovery from the bottoms. Second the saving of alloying metals can be accomplished by expanding the use in a number of branches of industry of new types of alloy steel, which do not contain the more valuable elements or contain them only in small quantity.

This article answers several questions which are included in the second part of the problem, i.e., the saving of alloying metals by the expanded use of new, more economical types of steel.

During past years, scientific research institutes and plant laboratories have done considerable work on the investigation and introduction of new and cheaper types of steel which has resulted in the saving of nickel and molybdenum.

Included in this has been work on the substitution for forging steels 5KhNM and 5KhGM of new types of forging steel which do not contain molybdenum. As a result, a saving of about 2 kilograms of molybdenum per ton of steel has been achieved. Instead of molybdenum-containing steel grade Kh12M, used for trimming dies and certain other tools, the new steel is employed, also resulting in a significant saving of molybdenum.

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In a number of machine building plants, instead of chrome-nickel-molybdenum and chrome-nickel construction steel, steel containing neither molybdenum nor nickel has been used. Instead of tool steel grade KhVG, a new steel grade KhGS has been introduced in order to save tungsten and to lower the cost of the steel.

Nevertheless, operations in carrying out experiments in the use of new, more effective, and cheaper steels with a smaller content of valuable alloying components are not yet satisfactory.

At present, there are still many possibilities for conserving alloying metals and alloys in all branches of industry which produce and consume alloying metal. Several branches of industry, for no apparent reason, use expensive types of steel containing a large quantity of alloying components not necessary for the use to which the steel is put. A number of new types of steel and alloys have been tested for a long time and are slowly being put into production.

The problem of saving alloying metals, in particular molybdenum, cobalt, nickel, copper, and the like, must be worked out both in respect to putting into use in industry types of steel already developed and in respect to further research on new, economical types of steel and alloys, which should also possess a number of technological advantages.

To solve the problem of substitutes for valuable alloying elements, it is necessary to study the possibility of extending the use of vanadium, boron, zirconium, and niobium.

Vanadium is a good reducing agent, which has a decided influence on reducing the susceptibility of steel to overheat during tempering. For this purpose, only a small quantity -- up to 0.10 percent -- need be added to the steel.

In tool steels, vanadium is used to achieve the tempering to only a small depth and to decrease the susceptibility to overheating. Before 1940, the metallurgical industry produced instrument steel grade F, containing vanadium within limits of 0.2-0.4 percent, for the manufacture of drills, matrices, and broaches. In 1940, this steel was removed from production because of the shortage of vanadium at that time; it is now expedient to bring up the matter of reviving its production.

Vanadium also plays an important role in the resistance to annealing, which is important in structural and forging steels worked under conditions of increased temperatures.

Positive results have been obtained by the introduction of vanadium into forging steel for the cold shaping of metals in place of molybdenum steel grade Kh12M. The use of vanadium forging steel should be expanded, and experiments on high-speed steel with increased vanadium content should be speeded up.

In particular, vanadium has proved of value as an element which increases the heat-resistance of steel, thus permitting the creation of vanadium creep-resistant steel for high-pressure boilers. In these steels the molybdenum is partially replaced by vanadium, and the characteristics of such steel satisfies the requirements demanded of chrome-molybdenum steels.

Boron is an extremely valuable element, in particular one which can be substituted for nickel. Boron in steel results in an increase in the annealability and an improvement in the mechanical characteristics of the metal. This makes it possible to substitute it in steels, alloyed with nickel and chromium, for part of these elements.

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Experiments have shown that 0.0025-0.0030 percent of boron can be substituted in steel for certain quantities of one of the alloying elements, as shown in the following table.

Name of Replaced Alloying Element	Quantity of Element Replaced by Substitution in Steel of 0.0025-0.0030 Percent Boron (in percent)
Nickel	1.00-1.25
Molybdenum	0.10-0.25
Chromium	0.30-0.35
Manganese	0.20-0.70
Vanadium	0.12
Silicon	1.60

These figures are approximate and indicate the effectiveness of the influence of boron on certain qualities of steel, especially on its annealability. The valuable qualities of boron show why during the past years great significance has been attached in a number of capitalist countries to experimentation and production of boron-containing steels.

Because of the large supplies of boron-containing ore in the USSR, the wide use of boron in the production of steel with the object of economizing on valuable alloying elements has an important role.

In Soviet plants the production technology of ferroboron and complex reducing agents containing boron has been perfected.

The scientific research projects carried on by a number of institutes and plants have shown the possibility of using boron-containing steels in place of regular alloy steels. However, up to now the results of this work have not been used widely in the USSR machine building industry.

Zirconium is a valuable alloying element. In addition, according to the literature from research data, zirconium, in the pickling of steel, reduces the content of nitrogen and nonmetallic substances.

Zirconium has a decided influence on the character and dispersion of sulfur impurities in steel. As a result, it is a useful element in free-cutting steel and makes easier the hot-shaping of this type of steel. Zirconium increases the annealability and heat-resistance of the steel and improves the quality of the impact strength of carbon steel in temperatures down to minus 60 degrees, the quality of corrosion fatigue of boiler steel, and the quality of resistance to scale.

The introduction of zirconium into medium-alloyed chrome steel has revealed a significant influence on the increase of annealability, resistance to waste, and improved strength under the influence of high temperatures.

Niobium, which has a strong influence on the heat- and creep-resistance of steel is very important. Niobium has shown a decided influence on the quality of cracking steel, as well as on the quality of steel used for the pipes of high-pressure superheating boilers.

Work on extending the use of niobium in the production of a number of heat-resistant alloy steels must be continued, keeping in mind its favorable action on several qualities of steel -- the increse of creep resistance and the small tendency to harden -- which are very important in the welding of steel.

Special emphasis should be placed on the investigation and use of those types of alloy steels in whose composition less valuable and less expensive alloying elements play a basic role.

The relatively cheap alloying elements include, first of all, manganese, which is still not used often enough as a supplementary element, and boron, which has scarcely been employed at all in the USSR for the alloying of steel. The use of these alloying elements leads to a significant improvement in the strength characteristics and annealability of carbon and alloyed types of steel, which makes it possible to substitute them for a number of steels having more valuable elements in their composition.

Institutes and plants are now investigating new types of steel and alloys without a molybdenum content; the extensive introduction in industry of the new steels and alloys has resulted in a significant saving of molybdenum.

Thus, a number of types of structural steel, which have been subjected to hardening and proper annealing, and also steel grade 38KhMYuA, used for the nitriding of products, have been used in the machine building industry. The available scientific research data show the possibility of substituting for specific molybdenum-containing types of steel, steel without molybdenum, the characteristics of which satisfy the required specifications. To begin with, it would be expedient to substitute such grades of steel as 38KhMYuA, 40KhNMA, 45KhNMFA, which are used in great quantity and which have a large specific weight, for those containing molybdenum in the production of all structural steels. The use of new types of structural steel would result in an average saving of 2-2.5 kilograms of molybdenum per ton of steel.

Great significance is also attached to the mastery of production and use of new heat-resistant steels. Recently, molybdenum and chrome-molybdenum steels of grades 12MKh, 15M, 20M, and 15KhM, which possess very high creep limits in comparison with carbon and chromium steels, have been used widely for the steam pipes of high-pressure boilers. Chrome-molybdenum steel grade Kh5M is used for cracking pipes, and grades 30KhMA and E110 as reinforcing materials for various purposes.

All these heat-resistant steels, possessing special qualities -- adequate heat-durability, resistance to creep, and, for reinforcing steels, also resistance to relaxation -- are used widely in industry and have, until recently, appeared to be irreplaceable. However, scientific research during recent years has shown the possibility of creating new heat-resistant types of steel which guarantee the saving of a considerable amount of molybdenum. The new types of steel have been shown to be equal in all respects to the steels now in use.

The introduction of new heat-resistant steel containing little or no molybdenum has resulted in a considerable saving of molybdenum. Thus, the replacement of grades 15KhM, 12MKh, 15M, and 20M by new heat-resistant steels for high-pressure steam pipes for boilers yields a saving of about 2 kilograms of molybdenum per ton of steel.

New types of non-molybdenum steel have been substituted for steels of grades 30KhMA and E110, used as reinforcing material under increased temperatures. They guarantee a saving of about 2-3 kilograms of molybdenum per ton of steel.

Despite this, the Ministries of Heavy Machine Building and Transportation are neglecting to take all possible steps to speed up the examination and use in production of non-molybdenum, heat-resistant types of steels.

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Serious charges can also be made against the Ministry of the Metallurgical Industry, which is only slowly preparing an experimental consignment of pipe from the new non-molybdenum type of steel. Steel without molybdenum has now been substituted for steel grade Kh5M in the production of oil-refinery pipe. This has resulted in a saving of about 5 kilograms of molybdenum per ton of steel.

Besides its use as an alloying admixture in steel, molybdenum is also used in its pure form, for example, for filaments in light bulbs, and for wires in radio tubes. As experimental work has shown, molybdenum wire used at present for radio-tube grids can be replaced by nickel-molybdenum alloys containing 20-30 percent molybdenum. The use of this alloy guarantees a saving of about 750 kilograms of molybdenum per ton of wire.

Recently, experimental work has been completed in scientific research institutes and plant laboratories on new steels and alloys which contain no nickel or a reduced quantity of it. This has resulted in a significant saving of nickel. For example, the addition of boron to structural steels makes it possible to reduce the nickel content by one percent. Manganese is also used because, at a somewhat increased quantity in the steel (separately or together with boron), it permits the reduction of nickel content in a number of structural steels.

The use of the new types of steel in place of steels having a higher alloy content of nickel has resulted in a saving of about 10-15 kilograms of nickel per ton of steel.

Chrome-nickel alloys with a high content of nickel (nichrome grade Kh15N60 and Kh20N80) are used widely as resistance-heating elements for electric furnaces and as various other resistance elements. The use of chrome-aluminum alloys for ohmic resistance instead of grades Kh15N60 and Kh20N80 has resulted in a saving of about 700 kilograms of nickel per ton of metal.

A significant saving of nickel will also result from a wider use of chromium stainless steel instead of chrome-nickel austenite stainless steel types Ya1 and Ya1T in the production of a number of items.

The saving of cobalt also is of considerable significance in industry since it is used for the production of alloys in considerable quantity. In the near future, experimental work in the development of new alloys containing little or no cobalt must be carried out. For example, the use of an alloy containing no cobalt instead of the conventional type will result in a saving of about 600 kilograms of cobalt per ton of metal.

As for copper, besides the amount saved in a number of branches of industry by the use of other materials, another source of saving for the current Five-Year Plan is the wide use in a number of cases of bimetallic wire instead of copper. This will require the development of new technological processes to produce such wire. The use of bimetallic wire instead of copper will result in a saving of about 700-800 kilograms of copper per ton of wire.

The introduction of measures for saving molybdenum, nickel, cobalt, and copper will not, it is understood, completely solve this important problem, but will emphasize the fact that there are still important possibilities in Soviet industry for saving alloying and nonferrous metals. Such measures also emphasize the need for improving the planning and organization of experimentation on less valuable materials and their introduction in industry.

In addition, it should be noted that when, certain quantities of alloying metals are freed, it becomes possible to organize the production and wide use of low-alloy steels with increased qualities of durability. This will have a very great significance in reducing the weight of machines, i.e., for lowering the output of metal per unit of equipment.

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